UNIVERSITI PUTRA MALAYSIA

A KNOWLEDGE AUDIT MODEL FOR REQUIREMENT ELICITATION PROCESS

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A KNOWLEDGE AUDIT MODEL FOR REQUIREMENT ELICITATION PROCESS

By

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Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

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DEDICATION

I want to dedicate this thesis to my dearest family, especially to my parents, Mr. Majid and Ms. Farideh, and my dearest brother, Mr. Kaveh for their care, support, patience and love throughout my journey of study.

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Master of Science

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December 2015

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Knowledge plays an important role in the success of any organization. Software development organizations are highly knowledge-intensive organizations especially in their requirement elicitation process (REP). There are several problems regarding communicating and using the knowledge in REP such as misunderstanding, being out of scope, conflicting information and changes of requirements. Because there are different people involved in REP and these people are from different backgrounds have different knowledge. Different areas of knowledge lead to different ways of knowledge expression and negatively affect knowledge understandability and completeness. Ambiguity in knowledge results in incorrect interpretation of knowledge and requirements. To allay these problems, it is necessary to identify and assess the knowledge. Knowledge Audit (KA) is the process of knowledge analysis and assessment that aims to answer these questions: what knowledge exists and what knowledge is missing as well as assess the knowledge in terms of completeness, correctness and understandability. Since there is a lack of KA model and knowledge assessment in REP, this research tends to fill this gap. Therefore, this research introduces a knowledge audit (KA) model to support knowledge communication of people who are clients and developers in REP. A survey on 40 respondents of clients and developers consisting of system analysts, system developers, project managers and clients during a focus group is conducted. KA is described through four main knowledge components for the model: 1) knowledge sources, 2) requirements knowledge, 3) knowledge inventory, and 4) audited knowledge. The findings revealed confirmatory of the model after some refinements. The results have confirmed the identified KA components and their elements as well as the inter-relationship among them. This research also develops a prototype based on the proposed model to validate the model through post study. The findings of post study also confirmed the effectiveness of KA model for REP on

the criteria of completeness, correctness, and understandability. The contribution of this research lies in the KA model that illustrates the KA components with the focus of knowledge assessment in REP to fill the exiting gap in this area. It also provides a prototype to assist software developers in REP. Overall, it introduces a KA model for REP to identify and assess knowledge which leads to the success in the process of requirement elicitation.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk ijazah Master Sains

MODEL AUDIT PENGETAHUAN UNTUK PROSES PEMEROLEHAN KEPERLUAN

Oleh

LALEH TAHERI

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Pengetahuan memainkan peranan yang penting dalam kejayaan sesebuah organisasi. Organisasi pembangunan perisian adalah organisasi yang sangat berintensifkan pengetahuan terutamanya dalam proses pemerolehan keperluan (REP). Terdapat beberapa masalah berkaitan komunikasi dan penggunaan pengetahuan dalam REP seperti kesalahfahaman, berada di luar skop, percanggahan maklumat dan perubahan keperluan. Ini kerana terdapat individu yang berbeza terlibat dalam REP dari latar belakang yang berlainan dan berbeza pengetahuan. Bidang pengetahuan yang berbeza membawa kepada pelbagai cara ekspresi pengetahuan dan memberikan kesan negatif terhadap kebolehfahaman dan lengkapan pengetahuan. Kekeliruan dalam pengetahuan menyebabkan salah tafsiran pengetahuan dan keperluan. Untuk mengurangkan masalah ini adalah perlu untuk mengenal pasti dan menilai pengetahuan. Audit pengetahuan (KA) adalah proses analisis dan penilaian pengetahuan yang bertujuan untuk menjawab soalan-soalan berikut: pengetahuan apa yang wujud dan pengetahuan apa yang hilang serta menilai pengetahuan dari segi lengkapan, ketepatan dan kebolehfahaman. Oleh kerana terdapat kekurangan model KA dan penilaian pengetahuan dalam REP, kajian ini cenderung untuk mengisi jurang ini. Oleh itu, kajian ini memperkenalkan model audit pengetahuan (KA) untuk menyokong komunikasi pengetahuan dalam REP antara pelanggan dan pembangun perisian. Kajian ke atas 40 responden yang terdiri daripada juruanalisis sistem, pembangun sistem, pengurus projek dalam satu kumpulan berfokus telah dijalankan. KA digambarkan melalui empat komponen pengetahuan utama untuk model: 1) sumber pengetahuan, 2) keperluan pengetahuan, 3) inventori pengetahuan, dan 4) pengetahuan teraudit. Hasil kajian menunjukkan pengesahan model selepas beberapa pembaikan. Keputusan telah mengesahkan komponen KA dikenalpasti dan unsur mereka di samping hubungan di antaranya. Kajian ini juga membangunkan prototaip

berdasarkan model yang dicadangkan untuk mengesahkan model dalam kaji selidik pasca. Hasil kaji selidik pasca juga mengesahkan keberkesanan model KA untuk REP bagi kriteria lengkapan, ketepatan, dan kebolehfahaman. Sumbangan penyelidikan ini terletak pada model KA yang menggambarkan komponen KA dengan memfokuskan penilaian pengetahuan dalam REP untuk megisi jurang sedia ada dalam bidang ini. Ia juga menyediakan prototaip untuk membantu pembangun perisian dalam REP. Secara keseluruhan, ia memperkenalkan model KA untuk REP bagi mengenal pasti dan menilai pengetahuan yang membawa kepada kejayaan dalam proses keperluan pemerolehan.

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Last but certainly not least, I wish to express my sincere appreciation to all my dear friends who have helped me in one way or another and always being there cheering me up.

I certify that a Thesis Examination Committee has met on 9 December 2015 to conduct the final examination of Laleh Taheri on her thesis entitled "A knowledge audit model for requirement elicitation process" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

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I hereby confirm that:

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Declaration by Members of Supervisory Committee

This is to confirm that:

- the research conducted and the writing of this thesis was under our supervision;
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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ET	Elicitation Technique
IDEC	Infocomm Development Centre
IT	Information Technology
ITM	Iterative Triangulation Method
K.Ass	Knowledge Assessment
KA	Knowledge Audit
KB	Knowledge Base
KM	Knowledge Management
KS	Knowledge Source
MARA	Majlis Amanah Rakyat
OOP	Object Oriented Programming
OWL	Ontology Web Language
REP	Requirement Elicitation Process
RK	Requirements Knowledge
SD	Software Development
SECI	Socialization, Externalization, Combination, Internalization
SNA	Social Network Analysis

CHAPTER 1

INTRODUCTION

1.1 Background

Knowledge plays a significantly important role to the success and constant progress in any organization. Accordingly, it is crucial for organizations to identify and manage the knowledge they possess (Choy et al., 2004). Knowledge Management (KM) is a process of capturing, creation, sharing and storage of knowledge (Burnett et al., 2013). KM ensures that "the neediest would gain right knowledge at right time" through knowledge sharing (Sulfeeza et al., 2014; Wu and Li, 2008). According to Choy et al., (2004) for conducting KM, it is critical to have an understanding of the organization's culture and background. Knowledge Audit (KA) is the key to gain such kind of understanding. Similarly, the main activity to identify knowledge assets is KA (Azizah and Nur Syufiza, 2011).

KA is a dynamic process to evaluate and assess knowledge policies, resources, structure, flow and need in organization. KA processes comprises of knowledge need analysis, knowledge flow analysis, knowledge mapping and knowledge inventory analysis (Perez-soltero et al., 2007). Thus, performing KA supports KM in knowledge creation, knowledge capture, knowledge sharing and knowledge storage. Although many researchers have focused on KA, yet there is inadequate research to come up with a standard KA model (Lee et al., 2007).

Software development (SD) organizations are recognized as highly knowledge-intensive organizations (Tiwana, 2003); especially in requirement elicitation process (Hickey and Davis, 2002).Requirement elicitation process (REP) is carried out in the beginning phase of any SD thus it is one of the important processes in SD according to Sommerville (2011).

REP aims to identify, acquire and elaborate the needs of clients for the software to be developed (Abdullah and Noraini, 2009). In eliciting requirements, stakeholders from various backgrounds needs to communicate together (Pilat and Kaindl, 2011) and reach consensus about the software requirements (Laporti et al., 2009). These stakeholders from different backgrounds have different knowledge. Dissimilarity of knowledge leads to several problems related to communicating and using the knowledge such as misunderstanding, conflicting information and constant changes of requirements and scope (Noraini and Abdullah Mohd, 2011b).

Problem of misunderstanding arise due to users or stakeholders' unclear needs and poor understanding of computer capabilities. The usage of different language between stakeholders causes missing information (Sommerville, 2011; Noraini and Abdullah Mohd, 2011a; Wohlin and Aurum, 2005; Christel and Kang, 1992). Noraini et al., (2011b) and Wohlinet al., (2005) mentioned problem of undefined scope implying that the boundary and scope of the system is obscure and not well-defined. On the other hand, different users may have inconsistent

and conflicting needs (Sommerville, 2011). In the following the way how these issues relate to knowledge are describe.

In REP stakeholders are divided to two groups of clients and developers. Clients usually express their needs in their own terms because the knowledge possessed by each team is different from developers (Pilat et al., 2011; Wan et al., 2009); the knowledge possessed by clients is mainly in business domain while the developers knowledge is mostly about SD and technical matters (Kaiya et al., 2010; Laporti et al., 2007). In addition, because of this different knowledge backgrounds, each stakeholder sees the prospective software from a different point of view (Laporti et al., 2007). Thus, different requirements leads to conflict and inconsistency (Nguyenet al., 2012; Sommerville, 2011). This problem is influenced by undefined scope because each stakeholder's expectation may fall in different scopes (Noraini et al., 2011b). Different areas of knowledge lead to different ways of knowledge expression and negatively affect knowledge understandability and completeness (Laporti et al., 2007). Ambiguity in knowledge results in incorrect interpretation of knowledge and requirements (Laporti et al., 2007).

It can be seen that REP faces problems regarding knowledge. To mitigate these problems it is necessary to identify the existing and missing knowledge and assess the knowledge. Therefore, KA is necessary as it aims to answer these questions: what knowledge exists and what knowledge is missing as well as assess the knowledge in terms of completeness, correctness and understandability (Leung et al., 2010; Liebowitz and Suen, 2000; Hylton, 2002). Therefore, the researcher believes that with the standing challenges of REP, our purpose to study KA in REP is rightly emphasized.

1.2 Problem Statements

As noted earlier, REP is known as a knowledge-intensive process since it involves numerous stakeholders. In reality however, it is difficult to communicate and use the knowledge (Noraini, 2011a).

As it is shown in Table 1.1 many researchers focused on knowledge in the requirement engineering and REP alongside KM approaches in REP (Pilat et al., 2011; Chikh, 2011; Wan et al., 2010; Wan et al., 2009; Herlea et al., 1997) but there is not any research to address KA in REP.

However, Maio, (2011) studied KA in system engineering not REP. Other attempts were made to study knowledge in REP; for example Hickey et al., (2002) showed the critical role of knowledge in performance of REP. The attributes of knowledge in REP were analyzed and a knowledge creation model for REP was introduced by Wan et al., (2010). Xiaohong, GuoRui and Tiyun, (2010) on the other hand, studied knowledge transfer in requirement engineering. The effect of domain knowledge on REP was studied by Niknafs and Berry, (2012). Other researchers focused on KM in requirement engineering

(Chikh, 2011; Pilat et al., 2011; Herlea et al., 1997), while another studied KM in software engineering (Rus et al., 2002).

Although many efforts have been carried out regarding KM in REP, there is no research about KA in this field. This is due to the present KA models which are static in nature, and they may not be flexible to adapt to different environments where KA is conducted (Sulfeeza and Siti, 2011). Since there is a great deal of knowledge involved in REP, there is a need to identify and assess the knowledge in REP with the help of KA. But there is no KA model for REP as it is shown in Table 1.1. This is identified as our first problem statement.

Additionally, the existing KA models in other fields do not provide sufficient details on how knowledge assessment is conducted during KA; this is also supported by Wai et al., (2014). Mostly knowledge assessment is conducted subjectively as in the studies done by Leung et al., (2010), Perez-Soltero et al., (2009), Sheck et al., (2007) and Choy et al., (2004); but there is a lack of objective knowledge assessment. This is recognized as our second problem statement. However, several studies employed social network analysis (SNA) for knowledge assessment (Chi, Chan, & Lee, 2011; Levantakis, Helms, & Spruit, 2008; Shek, Cheung, Lee, & Chong, 2007; Cheung, Li, Shek, Lee, & Tsang, 2007; Choy, Lee, & Cheung, 2004). SNA is used to assess the roles of the knowledge sources in the organization. With the help of SNA softwares, the level of network activity for knowledge and knowledge source is automatically and objectively measured (Nor, Abdullah, Selamat, & Murad, 2009). Though, SNA only assesses activity level of knowledge and knowledge sources and does not assess the attributes of knowledge. Based on the literature review, the existing models of KA are either not applicable to be generalized or highly contextual, or do not address the details of knowledge assessment in KA.

Table 1.1. Studies of knowledge in software development

Field / Study	Requirement Engineering	Requirement Elicitation Process	Software Engineering	Systems Engineering
Knowledge		Hickey et al., (2002)		
Knowledge Management	Pilat et al., (2011) ; Chikh, (2011) ; Herlea et al., (1997)		Rus and Lindvall, (2002)	
Knowledge Creation		Wan et al., (2010)		
Knowledge Conversion		Wan et al., (2009)		
Knowledge Transfer	Xiaohong et al., (2010)			
Domain Knowledge		Niknafs et al., (2012)		
Knowledge Audit				Maio, (2011)

1.3 Research Questions

This research posits the following questions:

- What are KA components involved in REP and how these components are related to one another?
- How can KA be implemented to support REP?

1.4 Research Objectives

Our research has three following objectives:

- To identify KA components and their relationships in REP as a model.
- To propose a model of KA for REP.
- To validate the KA model through a prototype by improving knowledge completeness, correctness and understandability.

1.5 Research Scope

This research aims to investigate the implementation of KA in REP and propose a KA model to assess knowledge in REP and mitigate requirement elicitation difficulties. Thus, the research scope have been defined as follows:

- Based on our interest, this study is confined to the REP and will not cover any other phases of SD.
- Based on the problems identified in Background, this study is confined to assess completeness, correctness and understandability of knowledge and will not assess other attributes of knowledge.
- This study is confined to implement the prospecting KA model and prototype in SD organizations in Malaysia.

1.6 Research Contributions

The contribution of this research is considered from both theoretical and practical aspects. The theoretical contribution lies in the KA model that depicts the KA components in REP and the relationships among them. The model depicts three main KA processes and four components with potentials to affect REP. The three processes are knowledge acquisition, knowledge flow analysis and knowledge assessment and the four components are knowledge sources, requirements knowledge, knowledge inventory and knowledge assessment result. In short, the model provides better perspective in terms of KA components and rest a good understanding of how KA can be implemented in REP.

Whereby, the practical contribution of the research lies in the development of the prototype based on the proposed model as well as implementation and testing of the prototype in real environment.

Another important contribution is the instrument used for the research data collections. There is a dearth of instruments for measuring KM-related constructs according Nissen and Jennex, (2005). This research has carefully designed and statistically validated instrument, therefore can be used for future researchers particularly in KA research work.

Last but not least, this research contributes to KA by developing a prototype which conducts KA for REP. The prototype helps both software developers and knowledge auditors to better identify and assess the knowledge.

1.7 Thesis Organization

The thesis is organized in accordance with the standard structure of thesis and dissertation at University Putra Malaysia. As the final report of this research, the thesis is organized in a way to provide detail information on how the research is performed. The thesis consists of seven chapters.

The first chapter of thesis brings up the background of the research. It expresses the researcher's motivation and research intention, objectives to study KA in REP; thereafter, the problem statement is explained, and scopes of the research and the research contributions are presented.

Chapter 2 is the Literature Review that gives a review and discussion of previous related works. In this chapter, resource materials such as journals, conference proceedings, books, seminar, thesis and online resources were used as the main references.

Chapter 3 is the Research Methodology. This chapter explains the research methodology used in this research. The methodology consists of seven stages. The first stage is performing theoretical study and literature review. The next stage is proposing the initial KA model based on the literature. In the third stage, the initial verification of KA model through Preliminary study was performed, while the next stage considers developing the prototype. In stage five post study will be conducted based on prototype to evaluate the model. Finally in stage six the results of the post study will be discussed and analyzed using SPSS.

Chapter 4 describes the preliminary study data collection, data analysis and results. The preliminary study aims to verify the identified KA components in REP as well as to determine the relationships of these components. The collected data is being analyzed using statistical analysis. The findings from this chapter provide the basis for proposing the KA model.

Next is Chapter 5 which describes the KA model along with its validation through the post study. This chapter presents the results of post study and model

validation. In this chapter, the components of the proposed model together with the justification for each component are elaborated.

Chapter 6 demonstrates the development of the prototype naming KARE. This chapter also describes the process of prototype development and provides the system design as well as different modules of the KARE. The examples of running the prototype are also presented in this chapter.

The final and conclusion chapter is Chapter 7. This chapter presents the conclusion of the research and its limitations, along with potential future research.

1.8 Summary

This chapter demonstrates the rational of this research and covers the problem statement and research questions. Research objectives and scopes are discussed in this chapter. The potential theoretical and practical contributions of this research are also presented. Ultimately, the summary of the thesis organization wraps up the chapter.

REFERENCES

Ahire, S. L., & Devaraj, S. (2001). An empirical comparison of statistical construct validation approaches. Engineering Management, IEEE Transactions on, 48(3), 319-329.

Aida S. S., Azizah A. R., and Wardah Z. A. (2009). Knowledge audit on special children communities. In Knowledge Acquisition: Approaches, Algorithms and Applications (pp. 198-207). Springer Berlin Heidelberg.

Antunes, B., Gomes, P., & Seco, N. (2007). SRS: a software reuse system based on the semantic web. In 3rd International Workshop on Semantic Web Enabled Software Engineering (SWESE).

Azizah, A. R., &Nur, S. Ahmad,S. (2011). Knowledge audit process-tales of two organizations. In Research and Innovation in Information Systems (ICRIIS), 2011 International Conference on (pp. 1-5). IEEE.

Balaid, A. S. S., Zibarzani, M., & Abd Rozan, M. Z. (2013). A Comprehensive Review of Knowledge Mapping Techniques. Journal of Information Systems Research and Innovation (JISRI), 61–66. Retrieved from http://seminar.spaceutm.edu.my/jisri/download/F_FinalPublished/Pub24_ReviewOF_KMappingTechniques.pdf

Bass, L., Clements, P., Kazman, R., & Klein, M. (2008). Models for Evaluating and Improving Architecture Competence, (March). Retrieved from http://www.sei.cmu.edu/library/abstracts/reports/08tr006.cfm

Bose, R. (2004). Knowledge management metrics. Industrial Management & Data Systems, 104, 457–468. http://doi.org/10.1108/02635570410543771

Brangier, É., Hammes-adelé, S., Paul, U., Metz, V., & User, E. A. (2011). Beyond the Technology Acceptance Model : Elements to Validate the Human-Technology Symbiosis Model, 13–21.

Burnett, S., Illingworth, L., & Webster, L. (2004). Knowledge auditing and mapping: a pragmatic approach. Knowledge and Process Management, 11(1), 25–37. http://doi.org/10.1002/kpm.194

Burnett, S., Williams, D., & Grinnall, A. (2013). The Strategic Role of Knowledge Auditing and Mapping: An Organisational Case Study. Knowledge and Process Management, 20(3), 161-176.

Cañas, A. J., Leake, D. B., Wilson, D. C., & Ave, S. W. (1999). Managing , Mapping , and Manipulating Conceptual Knowledge. In Proceedings of the AAAI-99 Workshop on Exploring Synergies of Knowledge Management and Case-Based Reasoning (pp. 10-14).

Cheung, C. F., Li, M. L., Shek, W. Y., Lee, W. B., & Tsang, T. S. (2007). A systematic approach for knowledge auditing: a case study in transportation sector. Journal of Knowledge Management, 11(4), 140-158.

Chi, P., Chan, W., & Lee, W. B. (2011). Knowledge Audit with Intellectual Capital in the Quality Management Process : An Empirical Study in an Electronics Company. Electronic Journal of Knowledge Management, 9(2), 98–116.

Chikh, A. (2011). A Knowledge Management Framework in Software Requirements Engineering Based on the SECI Model. Journal of Software Engineering and Applications, 4(12), 718.

Choy, S. Y., Lee, W. B., & Cheung, C. F. (2004). A Systematic Approach for Knowledge Audit Analysis : Integration of Knowledge Inventory , Mapping and Knowledge Flow Analysis. Journal of Universal Computer Science, Vol. 10, No. 6, 10(6), 674–682.

Christel, M. G., & Kang, K. C., Issues in requirements elicitation.SEI Joint Program Office, Publisher: carnegie-mellon univ pittsburgh pa software engineering inst.1992.

Coulin, C., Sahraoui, A. E. K., & Zowghi, D. (2005). Towards a collaborative and combinational approach to requirements elicitation within a systems engineering framework. In Systems Engineering, 2005. ICSEng 2005. 18th International Conference on (pp. 456-461). IEEE.

Cragun, B. J., & Steudel, H. J. (1987). A decision-table-based processor for checking completeness and consistency in rule-based expert systems. International Journal of Man-Machine Studies, 26(5), 633–648. http://doi.org/10.1016/S0020-7373(87)80076-7

Creswell, J. W. (2012). Qualitative inquiry and research design: Choosing among five approaches. Sage.

Dattero, R., & Galup, S. D. (2007). The knowledge audit: Meta-Matrix analysis. Knowledge Management Research & Practice, 5(3), 213-221.

Davenport, T. H., & Prusak, L. (2000). Working knowledge: How organizations manage what they know. Ubiquity ACM's magazine.

Davies, M. (2010). Concept mapping, mind mapping and argument mapping: what are the differences and do they matter? Higher Education, 62(3), 279–301. http://doi.org/10.1007/s10734-010-9387-6

Davis, A., Dieste, O., Hickey, A., Juristo, N., & Moreno, A. M. (2006, September). Effectiveness of requirements elicitation techniques: Empirical results derived from a systematic review. In Requirements Engineering, 14th IEEE International Conference (pp. 179-188). IEEE.

Debenham, J., & Clark, J. (1994). The knowledge audit. Robotics and computer-integrated manufacturing, 11(3), 201-211.

De Long, D. W., & Fahey, L. (2000). Diagnosing cultural barriers to knowledge management. The Academy of management executive, 14(4), 113-127.

Falbo, R. A., Arantes, D. O., & Natali, A. C. C. (2004). Integrating Knowledge Management and Groupware in a Software Development Environment. In the 5 th International Conference on Practical Aspects of Knowledge Management.

Falbo, R. D. A., Ruy, F. B., Moro, R. D., Avenue, F. F., & Brazil, V. E. S. (2005). Using Ontologies to Add Semantics to a Software Engineering Environment. In SEKE (pp. 151-156).

Ganasan, A. (2011). Knowledge audit made comprehensive thru 6 stages. In Research and Innovation in Information Systems (ICRIIS), 2011 International Conference on (pp. 1-6). IEEE.

Ghobadi, S., & D'Ambra, J. (2013). Modeling high-quality knowledge sharing in cross-functional software development teams. Information Processing & Management, 49(1), 138-157.

Gourova, E., Antonova, A., & Todorova, Y. (2009). Knowledge audit concepts, processes and practice. WSEAS Transactions on Business and Economics, 12(6), 605-619.

Haladyna, T. M. (1997). Writing Test Items To Evaluate Higher Order Thinking. Allyn & Bacon, 160 Gould Street, Needham Heights, MA 02194-2310.

Handzic, M., Lagumdzija, A., & Celjo, A. (2008). Auditing knowledge management practices: model and application. Knowledge Management Research & Practice, 6(1), 90-99.

Hartley, D., & Starr, S. (2010). Verification and validation. In Estimating Impact (pp. 311-336). Springer US.

Herlea, D. E., Shaw, M. L., & Gaines, B. R. (1997, March). Knowledge management for requirements engineering. In Proceedings of AAAI Spring Symposium on Artificial Intelligence in Knowledge Management (pp. 69-74).

Hickey, A. M., & Davis, A. M. (2003). Requirements elicitation and elicitation technique selection: model for two knowledge-intensive software development processes. In System Sciences, 2003. Proceedings of the 36th Annual Hawaii International Conference on (pp. 10-pp). IEEE.

Hicks, R. C., Dattero, R., & Galup, S. D. (2007). A metaphor for knowledge management: explicit islands in a tacit sea. Journal of Knowledge Management, 11(1), 5-16.

Hillston, J. (2003). Model Validation and Verification. Edinburgh: University of Edinburgh.

Hylton, A. (2002). Measuring & assessing knowledge-value & the pivotal role of the knowledge audit. London: Hylton Associates.

IEEE Standards. (1999). Software Requirements Specification. IEEE.

Jani, H. M. (2010). Applying Case-Based Reasoning to Software Requirements Specifications Quality Analysis System. In Software Engineering and Data Mining (SEDM), 2010 2nd International Conference on. IEEE, 2010. (pp. 140–144).

Kaiya, H., & Saeki, M. (2006). Using domain ontology as domain knowledge for requirements elicitation. In Requirements Engineering, 14th IEEE International Conference (pp. 189-198). IEEE.

Kaiya, H., Shimizu, Y., Yasui, H., Kaijiri, K., & Saeki, M. (2010). Enhancing domain knowledge for requirements elicitation with web mining. In Software Engineering Conference (APSEC), 2010 17th Asia Pacific (pp. 3-12). IEEE.

Kim, S., Suh, E., & Hwang, H. (2003). Building the knowledge map: an industrial case study. Journal of Knowledge Management, 7(2), 34–45. http://doi.org/10.1108/13673270310477270

Kumar, R. (2005). Research Methodology: A Step-by-Step Guide for Beginners. (Second, Vol. Vol. 2.).

Laporti, V., Borges, M. R. S., & Braganholo, V. P. (2007). A Collaborative Approach to Requirements Elicitation. 2007 11th International Conference on Computer Supported Cooperative Work in Design, 734–739. http://doi.org/10.1109/CSCWD.2007.4281527

Laporti, V., Borges, M. R., & Braganholo, V. (2009). Athena: A collaborative approach to requirements elicitation. Computers in Industry, 60(6), 367-380.

Lee, W. B., Shek, V., & Cheung, B. (2007). Auditing and mapping the knowledge assets of business processes–An empirical study. In Knowledge Science, Engineering and Management (pp. 11-16). Springer Berlin Heidelberg.

Leffingwell, D.& Widrig,D. (2003). Managing Software requirements: a use case approach. Addison-Wesley.

Leung, Z. C., Cheung, C. F., Chu, K. F., Chan, Y. C., Lee, W. B., & Wong, R. Y. (2010). Assessing knowledge assets: Knowledge audit of a social service organization in Hong Kong. Administration in Social Work, 34(4), 361-383.

Levantakis, T., Helms, R., & Spruit, M. (2008). Developing a reference method for knowledge auditing. In Practical Aspects of Knowledge Management (pp. 147-159). Springer Berlin Heidelberg.

Liebowitz, J., & Suen, C. Y. (2000). Developing knowledge management metrics for measuring intellectual capital. Journal of Intellectual Capital, 1(1), 54–67. http://doi.org/10.1108/14691930010324160

Likert, R. (1932). A technique for the measurement of attitudes. Archives of psychology.

Lindland, O. I. (1993). A Prototyping Approach to Validation of Conceptual Models in Information Systems Engineering (Doctoral dissertation, PhD thesis, IDT, NTH, Trondheim, Norway).

Maio, P. Di. (2011). Knowledge Audit Framework (for Systems Engineering) KAF-se. Retrieved from arXiv:1108.1490 [cs.OH]

Mason, M. (2010). Sample size and saturation in PhD studies using qualitative interviews. In Forum Qualitative Sozialforschung/Forum: Qualitative Social Research (Vol. 11, No. 3).

Naumann, F., & Rolker, C. (2000). Assessment methods for information quality criteria. Proceedings of 5th International Conference on Information Quality, p.148–162

Nguyen, T. H., Vo, B. Q., Lumpe, M., & Grundy, J. (2012). REInDetector: a framework for knowledge-based requirements engineering. In Proceedings of the 27th IEEE/ACM International Conference on Automated Software Engineering (pp. 386-389). ACM.

Nickols, F. (2000). The knowledge in knowledge management. The Knowledge Management Yearbook, 2000–2001.

Niknafs, A., & Berry, D. M. (2012). The impact of domain knowledge on the effectiveness of requirements idea generation during requirements elicitation. In Requirements Engineering Conference (RE), 2012 20th IEEE International (pp. 181-190). IEEE.

Nissen, M. E. (Ed.). (2005). Harnessing Knowledge Dynamics: Principled Organizational Knowing & Learning: Principled Organizational Knowing & Learning. IGI Global.

Noraini, C. P., &Sa'adah, H. (2012). Bridging Information and Knowledge using CodificationTechnology in Requirements Elicitation Process. In Knowledge Management International Conference (KMICe) 2012, Johor Bahru, Malaysia, 4 – 6 July 2012 180 (pp. 4–6).

Noraini,C. P., & Abdullah, M. Z. (2011a). Managing Communications Challenges in Requirement Elicitation. In Software Engineering and Computer Systems (pp. 803-811). Springer Berlin Heidelberg.

Noraini, C. P., & Abdullah, M. Z. (2011b). Requirement Elicitation: Identifying the Communication Challenges between Developer and Customer. International Journal of New Computer Architectures and their Applications (IJNCAA), 1(2), 371-383.

Nor Hapiza M. A., Abdul Razak H., Khairuddin O., and Norjansalika J. (2012, December). Customer Relationship Management (CRM) implementation: A soft issue in knowledge management scenario. In Humanities, Science and Engineering (CHUSER), 2012 IEEE Colloquium on (pp. 485-489). IEEE.

Nunnally, J. C., Bernstein, I. H., & Berge, J. M. T. (1967). Psychometric theory (Vol. 226). New York: McGraw-Hill.

Nuseibeh, B., & Easterbrook, S. (2000). Requirements engineering: a roadmap. In Proceedings of the Conference on the Future of Software Engineering (pp. 35-46). ACM.

Perez-soltero, A., Barcelo-valenzuela, M., Sanchez-schmitz, G., Martin-rubio, F., Palma-mendez, J. T., & Vanti, A. A. (2007). A Model and Methodology to Knowledge Auditing Considering Core Processes, 7–23.

Pietrantonio, R. (2006). Proposal of a knowledge audit metric based upon a compared analysis in private and public organizations.PHD Thesis, Università degli Studi di Napoli Federico II. Retrieved from http://www.fedoa.unina.it/721/

Pietrantonio, R. (2007). Assessment of the knowledge management systems in public administrations of Southern Italy. Vine, 37, 331–347. http://doi.org/10.1108/03055720710825645

Pilat, L., & Kaindl, H. (2011). A knowledge management perspective of requirements engineering. 2011 Fifth International Conference on Research Challenges in Information Science, 1–12. http://doi.org/10.1109/RCIS.2011.6006849

Prikladnicki, R., Audy, J., & Evaristo, R. (2003, May). Requirements management in global software development: Preliminary findings from a case study in SW-CMM context. In The International Workshop on Global Software Development (pp. 53-58).

Ragsdell, G., Probets, S., & Ahmed, G. (2013). Knowledge audit: findings from a case study in the energy sector. Knowledge and Process Management , Vol. 21 No. 4, pp. 270-279.

Ramadiani (2014), Integrated User-Interface Acceptance Model For E-Learning System.PHD Thesis, Universiti Putra Malaysia.

Rus, I., & Lindvall, M. (2002). Knowledge management in software engineering. IEEE Software (Vol. 19). Retrieved from http://ieeexplore.ieee.org/lpdocs/epic03/wrapper.htm?arnumber=1003450

Rusli, A., Mohd H. S., Shamsul S., Rose A. A. (2005). A Framework For Knowledge Management System Implementation In Collaborative Environment For Higher Learning Institution, (March), 4–7.

Salfarina A. (2012). A Model of Knowledge Transfer on Teams' Capability in Non-Collocated Software Architecture Development, PHD Thesis, Universiti Putra Malaysia.

Sekaran, U. (2000). Research Methods for Business: A skill-building approach. John Wiley abd Sons Inc.

Sharma, R., ChowdhuryN. (2007). On the use of a diagnostic tool for knowledge audits. Journal of Knowledge Management Practice, 8(4).

Sharma, R. S., Chia, M., Choo, V., & Samuel, E. (2010). Using A Taxonomy For Knowledge Audits : Some Field Experiences. Journal of Knowledge Management Practice, 11(1), 1–16. Retrieved from http://www.tlainc.com/articl214.htm

Shek, W. Y., Cheung, C. F., Lee, W. B., & Chong, Y. Y. (2007). Systematic Knowledge Auditing: A Case Study in a Power Utility Company. Journal of Information & Knowledge Management, 06(04), 231–239. http://doi.org/10.1142/S0219649207001809

Sommerville, I. (2011). Pearson Education Inc. Software Engineering (Ninth Edit).

Starr, R. R., & de Oliveira, J. M. P. (2013). Concept maps as the first step in an ontology construction method. Information systems, 38(5), 771-783.

Sulfeeza, M. D., Siti, S. M., Marini, O. (2014). Knowledge Audit and its link to Knowledge Strategy and Knowledge Management. Knowledge Management International Conference (KMICE).

Suo, B., Wang, J., Zhang, H. (2009). Primarily Research on Knowledge Audit for Evaluating Enterprise Knowledge Management Capability. International Conference on Management and Service Science

Tiwana, A. (2003). Knowledge partitioning in outsourced software development: A field study. ICIS 2003 Proceedings, 22.

Trochim, W. M. K. (1989). An introduction for planning to concept mapping.International Journal of Evaluation and Program Planning 12:0149-7189.

Veltri, S., Venturelli, A., & Mastroleo, G. (2015). Measuring intellectual capital in a firm belonging to a strategic alliance. Journal of Intellectual Capital, 16(1), 174–198. http://doi.org/10.1108/JIC-06-2014-0069

Wai, W. M., Ammuthavali R., Marini O. (2014). Development of Knowledge Assets Valuation Model. Knowledge Management International Conference (KMICe) 2014.

Wan, J., De-yi, H., & Wan Dan. (2009). Knowlegde Convertion in Software Requirement Elicitation. In The 1st International Conference on Information Science and Engineering (ICISE2009) (pp. 2328–2331).

Wan, J., Zhang, H., Wan, D., & Huang, D. (2010). Research on knowledge creation in software requirement development. Journal of Software Engineering and Applications, 3(05), 487.

Wang, S. (2011). On the Knowledge of Employee Engagement Factors. 2011 International Conference on Management and Service Science, 1–4. http://doi.org/10.1109/ICMSS.2011.5998027

Wohlin, C., Aurum, A. (Ed.). (2005). Engineering and managing software requirements. Springer Science & Business Media.

Wu, Y. L., & Li, Y. H. (2008). Research on the model of knowledge audit. In Wireless Communications, Networking and Mobile Computing, 2008. WiCOM'08. 4th International Conference on (pp. 1-4). IEEE.

Xiao J., Wang J. Peng J. (2010). Enterprise knowledge management audit based on processes: Toward an integrated conceptual framework. In Management of Innovation and Technology (ICMIT), 2010 IEEE International Conference on (pp. 940-945). IEEE.

Xiaohong, S., GuoRui J., Tiyun H. (2010). The Study on Knowledge Transfer of Software Project Requirements. In 978-1-4244-5316-0/10/$26.00 ©2010 IEEE.

Xiong, D., Xiangyun Z., and Zhao Q. (2007). Empirical Study on Innovation Competence Based on Tacit Knowledge. In Wireless Communications, Networking and Mobile Computing, 2007. WiCom 2007. International Conference on (pp. 5860-5863). IEEE.

Liu W., He K., Wang J., Peng R.(2007). Heavyweight semantic inducement for requirement elicitation and analysis. In Semantics, Knowledge and Grid, Third International Conference on (pp. 206-211). IEEE.

Zuher, A. H., &Mohd Sharifuddin A. (2011). Knowledge audit for References and Customer Services Unit at UNITEN library. In Information Technology and Multimedia (ICIM), 2011 International Conference on (pp. 1-6). IEEE.